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DETECTING ASSET PRICE BUBBLES DURING THE COVID-19 CRISIS AND ITS IMPLICATIONS: EVIDENCE FROM THE STOCK AND OIL MARKET

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ABSTRACT

This study investigates whether the COVID-19 pandemic has caused asset price bubbles in the stock and oil markets in the United States and Malaysia. More specifically, the study seeks to detect the onset and end of possible speculative bubbles and their causes in these markets. It also examines the existence of a contagion effect between the stock and oil markets during the Covid-19 pandemic. To achieve these objectives, the study used the Generalized SADF (GSADF) developed by Phillips et al. (2015) in order to check for existence of bubbles within the time frame from January 1, 2020, to April 24,2020. This technique allows one to look for the occurrence of multiple bubbles during the sample period with great precision. The findings showed that five out of the six equities, including the oil price indices had multiple bubbles. Evidence was also obtained which linked the explosive activity episodes between the crude oil market and the US stock markets from the start and end point of each bubble event. These findings add not only to the literature on the existence of bubbles in the financial and energy markets during the initial outbreak of COVID-19, but also to the significance of the negative impact of pandemics on bubble contagion effects under extreme market conditions.

Keywords: COVID-19, bubble, stock market, oil price, GSADF, financial crisis.

JEL Classification: C33, E44, G15 G21 G32.

INTRODUCTION

The world is currently paralyzed by the COVID-19 outbreak that began in Wuhan, China in late December 2019. The stock markets plummeted across the world as investors fled the markets. As the novel COVID-19 virus scare continues to create havoc in the capital markets, it is important to investigate the market crashes due to the pandemic. Baker et al. (2020) provides several reasons why such a pandemic has a powerful impact on financial markets. They argue that the gravity of this pandemic, its high contagiousness and the large number of infections and deaths resulting from it, have all contributed to making the stock market shock critical.

To underscore the gravity of the pandemic, Figure 1 shows the COVID-19 cases for China and selected Euro nations. Countries which have been recording the highest number of daily cases are China, Germany, Italy, Spain, and the UK. Except for China, the peak for these countries was detected between 9 March to 14 April 2020. In Malaysia, the jump in the number of daily new cases was detected from 13 March 2020 until 14 April 2020 (see Figure 2). As for the US, it started to show a jump in the daily new cases on 17 March and continued until late April 2020. The US reported the highest market turbulence since the global financial crisis in December 2008 (Baker et al., 2020). This was following the US stock market crash by 20 percent on 11 and 12 March 2020 (Giglio et al., 2020).

Figure 1

COVID-19 Cases for USA and Malaysia

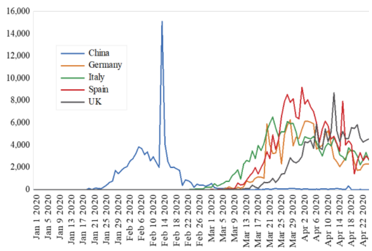
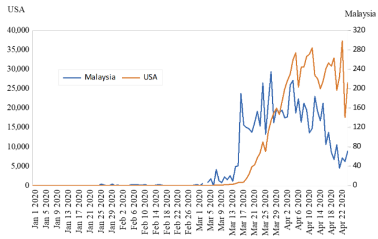


Figure 2

COVID-19 Cases for China and Euro Countries



While the global economy and financial markets have been in disarray, the recent oil price crisis caused by the Russia-Saudi Arabia price war has worsened the situation. Against the backdrop of lower oil demand due to the global economic lockdown[1], the Russia-Saudi price war has resulted in a 65 percent quarterly decline in oil prices[2]. Uncertainty in the real economy which was exacerbated by volatile oil prices has diminished economic growth and adversely impacted the stock markets (Degiannakis et al., 2018; Kilian & Park, 2009). Since oil price fluctuations have long been tied to stock market movements (Moya-Martínez et al., 2014; Waheed et al., 2018; Arouri et al., 2011; Kumar et al., 2012; Gomes & Chaibi, 2014), falling prices induced by COVID-19 (Ozili & Arun, 2020) has increased market risk aversion to levels not seen since the GFC (Yousef et al., (2021). The implied volatility of equities and oil rose to crisis levels as stock markets collapsed[3]. As a result, speculative bubbles have been common in significant parts of the financial markets, particularly during the early months of the pandemic outbreak. Motivated by these tumultuous events, the present study was aimed at examining the explosive behavior episodes in selected US and Malaysia stock markets during the first four months of the COVID-19 outbreak, which was from 2 January 2020 to 24 April 2020. This period was selected because it covered the non-COVID-19 phase (2 January, 2020 – 16 January, 2020) and the early pandemic phase (17 January– 24 April 2020). Since the period of study also coincided with the Saudi-Russia oil price war in early March 2020, the study also investigated the bubble episodes in crude oil market and determined whether there existed a contagion effect between the bubbles in the equity markets and the oil markets.

As the epidemic wreaked havoc on world markets, determining the exact date when the initial bubbles occurred, how long each bubble lasted and the possible causes for each bubble became important for policy makers and investors alike. This is especially true given that the pandemic is still having an impact on the equities markets, any significant increase in COVID-19 cases is likely to spark future episodes of explosive behavior in the stock markets. Therefore, to test for bubbles in the stock markets and energy sector, the Supremum Augmented Dickey–Fuller (SADF) test introduced by Phillips et al. (2011) and the Generalized SADF (GSADF) by Phillips et al. (2015) were also used in the present study. While the SADF test detects a single bubble episode, the GSADF test overcomes this constraint by assessing the explosive behavior with multiple bubbles, resulting in more robust estimations for the present study.

The USA and Malaysia stock markets were selected for the following reasons. First, the USA has the largest stock markets in the world and one of the earliest markets to jolt following the coronavirus outbreak in February 2020[4]. Second, the USA was also the largest oil producer in 2020, hence was directly affected by the oil price crash. Third, Malaysia was chosen due to its significant economic relations with the USA, with their bilateral trade volume surpassing RM100 billion in 2020, or 11.1 percent of the total Malaysian exports (MATRADE, 2020). Given that Malaysia was severely impacted by the GFC (Alp et al., 2012), which was precipitated by the collapse of the US subprime market, there was the anticipation that there would be a contagion effect from the asset price bubbles in the USA into the asset markets of Malaysia during the COVID-19 pandemic. The theorized contagion effect between these markets was seen as highly possible, given how strong the correlation between these markets was at the time of the study (evidence of this correlation is provided in the fourth section of the paper).

Besides the KLSE index, the present study also considered the Shariah Index for the asset price bubbles analysis of Malaysia. Given the differing rules and regulations that govern these two markets[5], this study wanted to examine if there was a major difference (or differences) in how these two indices responded to the turbulent market conditions during the COVID-19 epidemic. This was because the Islamic stocks were hypothesized to be less vulnerable to shocks due to the lower leverage, smaller business size, and under-diversified market (Rizvi et al., 2015). It has also been found that the Islamic finance portfolio performed better than their conventional counterpart in the early wake of the 2008 GFC (Zhang et al., 2020). Therefore, findings from the analysis in the present study have important implications for investors who are looking for an alternative form of stock market that will be better in safeguarding investors' rights from the numerous financial crises that have plagued the world over the past several decades.

This study reported in this paper contributes to the literature in several ways. First, it has shed light on the explosive behaviors and contagion effects in the US stock and crude oil markets during the initial phase of the COVID-19 outbreak from 2 January 2020 to 24 April 2020. Second, it has investigated bubbles episodes in the Malaysian stock market and its linkage with the implosion of COVID-19 cases from the US stock markets and crude oil markets. Third, it has compared the explosive behavior episodes between the conventional stock markets and the Islamic stock markets in the markets in Malaysia during the early wave of the COVID-19 pandemic. With this analysis, it was hoped that researchers can draw new insights about the reactions of investors and traders on these two markets during the initial pandemic outbreak.

The analyses have resulted in several significant outcomes. First, there was evidence of multiple bubbles in five out of the six of equity series. Second, there was evidence linking explosive behavior episodes between the crude oil market and the US stock markets from the date-stamp of the starting and ending points of each bubble incident. In contrast, the stock market in Malaysia exhibited explosive behavior more closely to the date-stamp of the COVID-19 implosion of local cases around the 13th of March, 2020. There was also evidence linking the bubbles episodes in the US and the crude oil market with the stock market in Malaysia. Finally, the empirical results showed that multiple bubbles episodes were detected in the Shariah stock market, as opposed to a single bubble in the KLSE index in Malaysia. Two bubbles episodes that were discovered only in the Shariah index corresponded to the initial spread of the COVID-19 virus in China, when the global market was still relatively unperturbed by the pandemic. The results of the present study seemed to suggest that the Islamic stock market could detect abnormal market behavior earlier, as compared to the conventional stock market. However, these results were limited to the Malaysian market experience, and more evidence is needed to generalize the findings to other Islamic stock markets.

The rest of the paper is organized as follows: Section 2 presents the literature review; Section 3 describes the method and data; Section 4 introduces the results and Section 5 concludes the paper.

LITERATURE REVIEW

The COVID-19 pandemic has been regarded as the most devastating worldwide health catastrophe since the Spanish flu in 1918. Nevertheless, there has been relatively little past research on how epidemics influence financial markets. As a result, the present study offers an important contribution to the literature in the field. According to Chen et al. (2009) and Loh (2006), the Severe Acute Respiratory Syndrome (SARS) outbreak had a detrimental impact on industries such as those in aviation, tourism, wholesale, and retail. Previous studies have also indicated that the severity of the pandemic might predict the likelihood of an equity market crash. Giglio et al. (2020) and Wen et al. (2019a, b), for example, demonstrated that short-run investor expectations might correlate with the risk of a stock market crash. However, previous research by Giglio et al. (2020, 2021) has also revealed that the likelihood of an equity market crash occurring before a crisis was lower since investors were more bullish about stock market returns.

Zhang et al. (2020) found that COVID-19's rapid spread had a major impact on financial markets worldwide, resulting in huge increases in the global financial market risk and huge losses to investors for a short period of time. The study by Zeren and Hizarci (2020) which looked at the impact of COVID-19 shock on the stock markets of six countries found a co-integrating relationship between the daily total case and stock markets returns. Yilmazkuday (2020) analyzed the COVID-19 impact on the S&P 500 index and found a significant relationship between the two. Awadhi et al. (2020) also examined the effect of COVID-19 on stock market returns and revealed that there were sectoral differences in the market returns. According to Mazur et al. (2020), the March 2020 financial market meltdown was caused by government reactions. Their analysis also corroborated the findings of Mishkin and White (2002), who discovered that a stock market crash might result in a loss of 20 percent –25 percent in the United States (U.S.) equities index, compared to past crises (e.g., World War I, World War II, and so on) owing to a series of panic selling.

Several studies have looked at asset price bubbles when markets were in distress. A recent study by Chang et al. (2021) showed the existence of bubbles in the US stock market during the early months of the COVID-19 outbreak by using the GSADF test. Focusing on the gold and crude oil markets, Gharib et al. (2021) discovered that there existed mild explosive price behaviors in the WTI and gold markets from January 4, 2010, to May 4, 2020. The most notable finding was that a bilateral contagion impact of bubbles was found during the recent COVID-19 outbreak in the oil and gold markets. Zhao et al. (2020) examined the bilateral contagion effect of bubbles between oil price and the Chinese stock markets. They detected six bubbles in the oil and stock markets from September 1, 2004, to July 9, 2018. Another study by Sharma and Escobari (2018) have highlighted the existence of bubbles in the energy sector. They found that a strong spike in oil prices had caused the bubble to explode in 2015. Li et al. (2020), in their study of natural gas price bubbles in three major economies from 1996 to 2017, found that the 2008 global financial crisis (GFC) contributed to the rapid variations in natural gas prices in all three countries.

RESEARCH METHOD AND DATA

Theory and Method

A large set of studies in the existing literature have investigated asset price bubbles using different asset-pricing models (Gürkaynak, 2008, De Long et al., 1990, Tirole, 1985). Price bubbles occur when commodity prices deviate from their true values. Many researchers have considered the model used by Gürkaynak (2008) as the most reliable one from among the others highlighted in the aforementioned studies. Three main assumptions formed the basis of the Gürkaynak model. First, market information is assumed to be non-asymmetric, such that uninformed traders are unable to influence asset price by manipulating information about prices. Second, consumers are assumed to be risk neutral with no premium on risk. This means that fluctuations in prices are not caused by risk premiums that varies with time and price variations. Third, the discount rate is assumed to remain constant. In short, the general model which allows for the presence of bubbles is given as follows:

$$P_t = (1 + r_f)^{-1} E_t(\partial_{t+1} + \mho_{t+1}) \quad [1]$$

where P_t is the asset price in time t and E_t signifies the expectation. The coefficients ∂_{t+1} and $\mho_{t+1}$ represent the return and hidden component for time t+1, respectively. For the present study Equation [1] has been transformed into the following Equation [2]:

$$P_t^f = \sum_{i=0}^{\infty} \left(\frac{1}{1+r_f}\right)^i E_t(\partial_{t+1} + \mho_{t+i}), i = 0,1,2 \dots n \quad [2]$$

where P_t^f is the underlying stock market (crude oil) index (price) and ∂_{t+1} is the stock market (crude oil) return in period ∂_{t+1}. Equation [2] represents the components of the underlying price without bubbles. The asset-pricing model with the presence of bubbles is depicted by the following Equation [3]:

$$P_t = P_t^f + B_t \quad [3]$$

Equation [3] is represented by two elements. The first element represents the present value of the projected capital return, and the second element captures the asset price bubbles. In Equation [3], price bubbles are treated as a factor in the pricing of an asset, rather than a collective error by traders. Thus, when assuming $B_t \neq 0$, an interesting premise can be articulated. Evans (1991) opines that the traditional unit root tests to ascertain price bubbles are ineffective when cyclical unsustainable behavior occurs in the period. Therefore, Phillips and Yu (2011) constructed the Supremum Augmented Dickey–Fuller (SADF hereafter) to detect explosive behaviors. The SADF test carries out the ADF test repetitively on a forward recursive sample sequence that is also connected to the right-sided ADF and sup tests. When the bubbles burst, the SADF test is shown to be more effective in detecting structural breaks than other tests (Homm & Breitung, 2012). The null hypothesis of $H_0: B = 1$ is rejected when the largest right-tailed ADF is bigger than the critical value, i.e. there is evidence of an asset price bubble. Details of the estimation process are given as follows in Equation [4]:

$$y_t = cN^{-\eta} + \theta y_{t-1} + \varepsilon_t \quad [4]$$

where *N* is the sample size, c is a constant, η>1/2, $\varepsilon_t \sim$ NID(0,θ^2), and θ=1.
Assuming that the regression sample begins from r_1 and ends at r_2 while r_w is the window size of the regression, such that $r_2 = r_1 + r_w.$, then Equation [4] can be written as Equation [5]:

$$\Delta y_t = \beta_{r1,r2} + \beta_{r1,r2} S y_{t-1} \sum_{i=1}^{k} \varphi_{r1,r2}^{i} \Delta y_{t-i} + \mu_t \qquad [5]$$

where *k* is the lag order and μ_t~NID(0,$\varphi_{r1,r2}^{i}$) The window size r_w lies between and 1. As suggested by Phillips et al. (2015), the window size r_0 for sample size *N* is determined as follows, using Equation [6]:

$$r_0 = 0.01 + 1.8.\sqrt{N} \qquad [6]$$

For example, a sample size of $N = 79$ requires a window size of 16. Following Phillips et al. (2015), the lag order is set to zero using the BIC information criterion. The critical values are calculated using the Monte Carlo simulation with 1000 replications. In addition, the parameters c and η of the data generating process (whereby *c* is the constant drift factor and η is a coefficient that controls the magnitude of the drift) is set according to Phillips et al. (2015) where $c = \eta = 1$ The asymptotic distribution of the SADF statistic may be summarized as follows in Equation [7]:

$$ADF \xrightarrow{L} \sup_{r\omega \in [r_0,1]} \left\{ \frac{r_w\left[\int_0^{r_w} W dW - \frac{1}{2} r_w\right] - -\int_0^{r_w} W dr . W(r_w)}{r_w^{1/2}\left\{r_w \int_0^{r_w} W^2 dr - \left[\int_0^{r_w} W(r) dr\right]^2\right\}^{1/2}} \right\} \qquad [7]$$

where W is the standard Wiener process. Despite the superiority of the SADF over traditional unit root tests in distinguishing bubbles, it lacks the ability to detect several bubbles across an extended horizon. As shown by Phillips et al. (2015), the SADF is unable to pick up multiple occurrences of bubbles when the period is prolonged. Correspondingly, Phillips et al. (2015) has introduced the Generalized sup ADF (GSADF) by adjusting the beginning and ending points, thus allowing for a more flexible window size in the estimation process. The GSADF is useful when analyzing the volatile behavior of an asset price with several parts in a long period which includes several subsamples for this procedure. The GSADF is represented in the Equation [8]:

$$GSADF = \sup_{rw \in [r_0,1]} \left\{ sup_{r_1 \in [0,1-r_w]} ADF_{r_1}^{r_w} \right\} \qquad [8]$$

Data

The present study has examined the asset price bubbles due to the COVID-19 outbreak during the period from January 2, 2020, to April 24, 2020. Four daily equities, namely two American stock markets indices (S&P 500 (^GSPC) and Dow Jones (^DJI)), two Malaysian stock market indices (FTSE Bursa Malaysia (^KLSE?P=^KLSE) and Emas Shariah (FBMS.FGI)) were sourced from Yahoo Finance (https://finance.yahoo.com). For oil prices, two indices (WTI Spot Crude and NYMEX Futures) were sourced from the US Energy Information Administration (https://www.eia.gov/petroleum/data.php).

Table 1

Summary Statistics on Stock Market Indices and Oil Markets

	Dow Jones	S&P 500	KLSE	Shariah	NYMEX	Spot Crude
Mean	25801.71	2985.72	1461.79	11043.17	40.56	40.36
Maximum	29551.42	3386.15	1611.38	12104.30	63.27	63.27
Minimum	18591.93	2237.40	1219.72	9120.49	-37.63	-36.98
Std. Dev.	3344.77	340.71	109.40	865.65	17.66	17.99
Skewness	-0.42	-0.46	-0.39	-0.51	-1.25	-1.20
Kurtosis	1.73	1.83	1.86	2.00	6.01	5.50
Jarque-Bera	7.61***	7.33***	6.41***	6.87***	48.41**	37.96**
Observations	79	79	81	81	76	76

Note. Dow Jones denotes Dow Jones Industrial Average, KLSE denotes FTSE Bursa Malaysia KLCI, Shariah denotes FTSE Bursa Malaysia EMAS Sharia, NYMEX denotes NYMEX Futures, Spot Crude denotes WTI Spot Price.
Note. **, *** Indicates statistical significance at 5% and 1% level, respectively.

Table 1 shows the summary statistics for the four stock market indices and two oil price measures. The range of stock indices in percentage terms was 37 percent for the Dow Jones and 34 percent for the S&P 500. For the KLSE and the Shariah, the variation was 24 percent each from January,1 to April,24 2020. Fluctuations in crude oil prices were more severe, accounting for 158 percent during the sample period, largely attributed to the unprecedented drop to negative value for first time in history on 20th April 2020 at USD37. These large and drastic fluctuations of prices were the result of the severity of the impact of COVID-19 on these markets, and which increased the likelihood of causing bubbles. Furthermore, all prices exhibited negative skewness, with similar skewness value for the four stock market indices and two oil price measures. According to the Jacque-Bera test of normality, none of the prices were normally distributed. The present study then tested the pairwise correlation between prices of different equity pairs, as is shown in Table 2. The observed correlations between the markets in the USA and Malaysia were high and significant at the 1 percent level of significance. Similar positively significant correlations between the crude oil prices and the stock markets in the USA and Malaysia were recorded. The significant correlations between the six equities seemed to suggest the possibility of contagion effects from speculative bubbles in the stock and oil markets during the epidemic.

Table 2

Correlation Statistics of Stock Market Indices and Oil Price

Correlation	Dow Jones	NYMEX	S&P 500	KLSE	SHARIAH	Spot Crude
Dow Jones	*NA*					
NYMEX	0.78719*	*NA*				
S&P 500	0.99049*	0.76149*	*NA*			
KLSE	0.87351*	0.90628*	0.84603*	*NA*		
Shariah	0.88625*	0.89566*	0.86239*	0.98933*	*NA*	
Spot Crude	0.79376*	0.99045*	0.76916*	0.91176*	0.90353*	*NA*

Note. Dow Jones denotes Dow Jones Industrial Average, KLSE denotes FTSE Bursa Malaysia KLCI, Shariah denotes FTSE Bursa Malaysia EMAS Sharia, NYMEX denotes NYMEX Futures, Spot Crude denotes WTI Spot Price.
Note. * denotes significant at 1% level of significance.

RESULTS

Table 3 presents the SADF and the GSADF test results for the six asset prices. Each test was achieved by performing 1000 replications of the Monte Carlo simulations. Both the statistical values of the GSADF and the SADF for Dow Jones and the S&P 500 indices were > 99 percent of the threshold level. For example, in the case of the S&P 500, the statistical value of the GSADF test and the SADF test were 2.19 and 1.93, respectively and exceeded the 99 percent threshold level of 1.57 for the GSADF and 1.08 for the SADF. For the KLSE and Shariah markets, the GSADF tests values exceeded 95 percent, while the SADF statistical values were > 99 percent of the threshold. Regarding oil prices, the statistical values of the GSADF were 1.92 for the NYMEX and 1.12 for the Spot Crude, respectively. The former exceeded the 99 percent threshold, whilst the latter exceeded the 95 percent threshold. The statistically significant results indicate the presence of bubbles between January 2020 and April 2020, hence supporting the notion of COVID-19 induced uncertainty shocks in these markets.

Table 3

Results of the GSADF and SADF tests for Stock Market Indices and Oil Market

Market	Test method	Statistical value	Critical level	99%	95%	90%
Dow Jones	GSADF	1.71***	GSADF Threshold	1.57	1.13	0.93
	SADF	1.71***	SADF Threshold	1.08	0.45	0.23
S&P 500	GSADF	2.19***	GSADF Threshold	1.57	1.13	0.93
	SADF	1.93***	SADF Threshold	1.08	0.44	0.22
KLSE	GSADF	1.43**	GSADF Threshold	1.54	1.09	0.86
	SADF	1.38***	SADF Threshold	0.9	0.39	0.15
Shariah	GSADF	1.14**	GSADF Threshold	1.55	1.12	0.89
	SADF	1.09***	SADF Threshold	0.9	0.4	0.18
NYMEX	GSADF	1.92***	GSADF Threshold	1.55	1.1	0.91
	SADF	0.56**	SADF Threshold	0.94	0.45	0.2
Spot Crude	GSADF	1.12**	GSADF Threshold	1.55	1.1	0.91
	SADF	-0.04	SADF Threshold	0.94	0.45	0.2

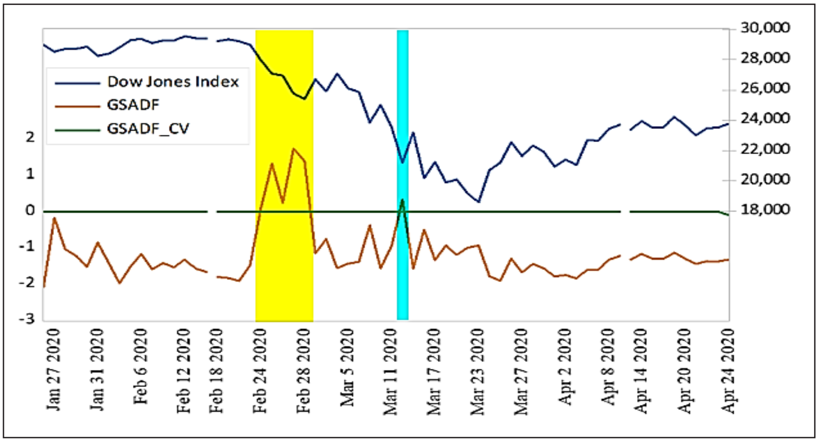
Note. Dow Jones denotes Dow Jones Industrial Average, KLSE denotes FTSE Bursa Malaysia KLCI, Shariah denotes FTSE Bursa Malaysia EMAS Sharia, NYMEX denotes NYMEX Futures, Spot Crude denotes WTI Spot Price.
Note. **, *** Indicates statistical significance at 5% and 1% level, respectively.

Since the GSADF test is prone to succeeding bubbles and results from the GSADF tests have shown that each price index has surpassed the threshold values at 95 percent level, the analysis in the present study had proceeded by comparing the GSADF statistical values with the GSADF sequence threshold's critical value for the four stock markets and two oil price indices at the 95 percent sequence. The graphical assessment in Figures 3-8 shows the date-stamp for the beginning and end of each bubble. For the purpose of comparison, the original data series were plotted in the same figures and corresponds to the right vertical axis.

Figures 3-4 plot the corresponding GSADF statistics (the brown line) against the corresponding 95 percent threshold (the green line) for the Dow Jones and the S&P500 during the COVID-19 pandemic. The date of beginning is identified as the first point when the GSADF statistics surpassed the critical value. The end date is equivalent to the point after the date of origin when the GSADF statistics dropped below the threshold value. These periods are represented by the shaded areas as identified by Equation (8). Figure 3 and Figure 4 show evidence of two statistically significant bubbles, with the first bubble detected on the 21st of February and lasted around seven days. During this short span of time, both indices suffered a 12 percent drop in the index. The second successive bubble was detected on the 12th of March and lasted for two days, when both markets registered a 10 percent drop in the index. These results are in line with the findings in Chang et al. (2021). These two consecutive short bubbles in these two US stock markets coincided with the declining global oil demand, as reflected by the persistent drop in crude oil prices as much as 22 percent from 20th February to 13th March 2020. This was largely due to the weakened global oil demand, as China shut its economy to curb the spread of the virus and many countries began to limit or suspend air travels to and from China. The explosive behavior episodes of the Dow Jones and the S&P500 were a manifestation of the adverse economic impact of the Coronavirus outbreak and this was made worse after the Russia–Saudi Arabia oil price war which started on the 8th of March 2020.

Figure 3

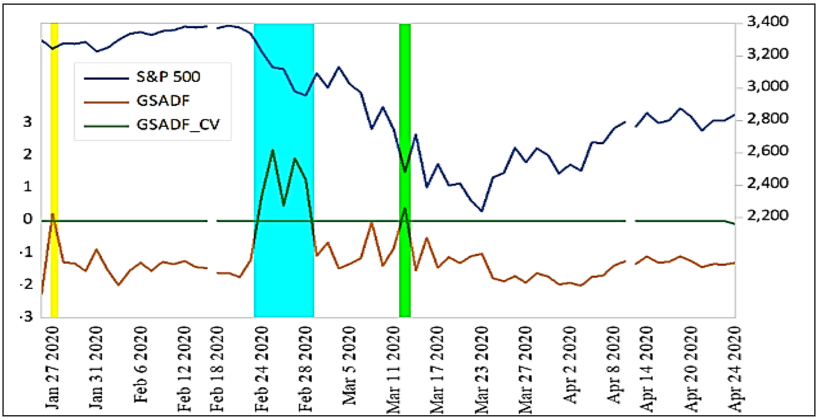
Bubbles Date Stamp for Dow Jones Index



Note. GSADF denotes GSADF sequence; GSADF_CV denotes 95% critical value sequence.

Figure 4

Bubbles Date Stamp for the S&P500 Index

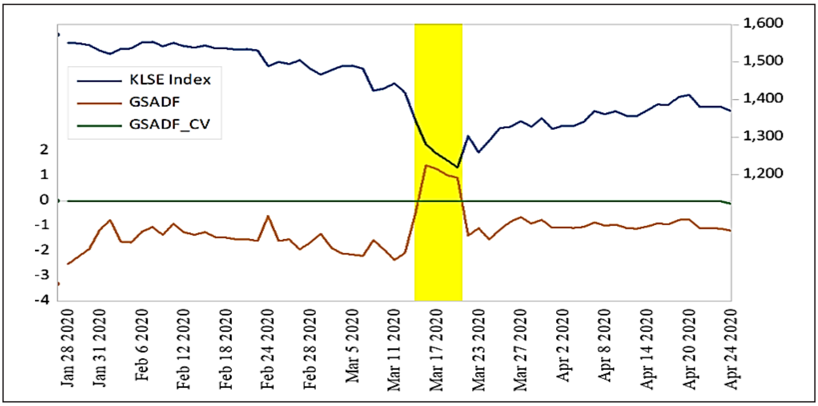


Note. GSADF denotes GSADF sequence; GSADF_CV denotes 95% critical value sequence.

Figure 5 and Figure 6 show the bubble episodes for the stock market in Malaysia, in particular, the KLSE and the Shariah. Following the earlier mentioned similar approach, the shaded areas corresponded to the starting and ending episodes of exuberance in stock prices, as identified by the GSADF using the 95 percent threshold values derived from the Monte Carlo simulations.

Figure 5

Bubbles Date Stamp for the KLSE Index

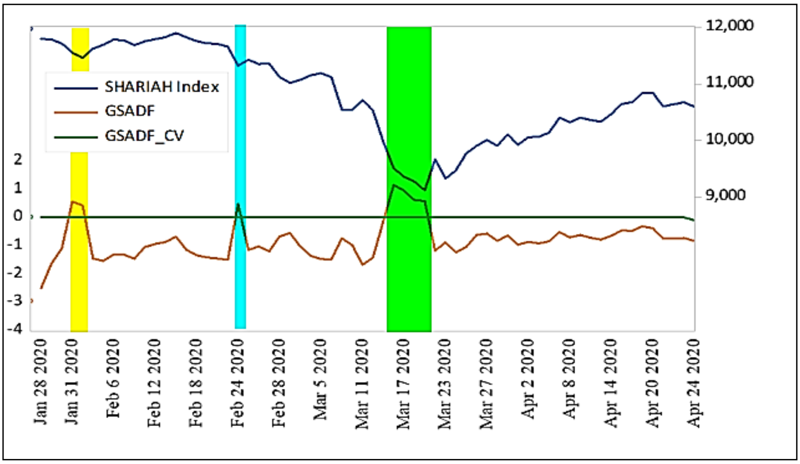


Note. GSADF denotes the GSADF sequence; GSADF_CV denotes the 95% critical value sequence.

For the KLSE, only one episode of bubble was detected between March,13 and March 21, 2020. The inception date of the bubble for this period corresponded to the sudden spike in COVID-19 cases in Malaysia, from the daily confirmed cases of 9 on 13th March to 190 confirmed cases on 16th March 2020 (see Figure 2). Although the Shariah index experienced an explosive episode around the same starting date as that of the KLSE, the GDASF test picked up two prior bubbles for the Shariah as is shown in Figure 6. There was a double sudden explosion in prices on 31st January and 24th February 2020. The implosion on 31st January was likely a response to the surge in the COVID-19 confirmed cases in China by 10,000 percent between 20th January-31st January 2020 (see Figure 1), while the explosive behavior on the 24th of February might be rooted in the continuous drop in oil prices after hovering around 53 US dollars for several weeks and has never recovered since. The second bubble on February 24 might also be due to the political upheaval in Malaysia when the Pakatan Harapan coalition government collapsed on 24 February 2020 (Ho Wah Foon), it created a power vacuum when the then Prime Minister, Tun Dr. Mahathir Mohamad resigned. The stock market slid down further and subsequently led to the third bubble in the Shariah index following the sudden surge in COVID-19 cases and the imposition of a nationwide partial lockdown by the Malaysian government.

Figure 6

Bubbles Date Stamp for the Sharia Gold Index

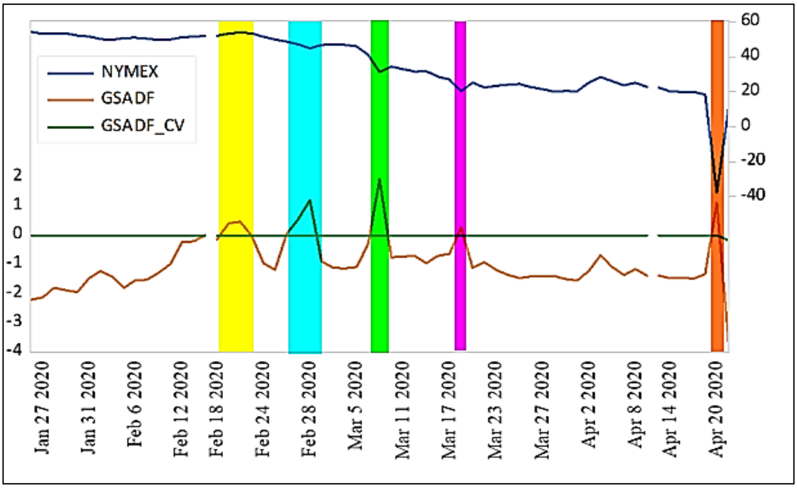


Note. GSADF denotes the GSADF sequence; GSADF_CV denotes the 95% critical value sequence.

Figure 7 and Figure 8 display the bubbles episodes for the crude oil market. They show the multiple explosive behavior episodes for the NYMEX and the Spot Crude prices between 18th February and 20th April 2020. Both the oil price measures exhibited two bubble incidents on the 18th and 26th of February 2020 and these lasted for three days, respectively. The collapse of the oil price bubble in February was initiated by the abrupt decline in the world oil demand. This was a consequence of the widespread shutdown of China's economy, which was hit hard by COVID-19.

Figure 7

Bubbles Date Stamp for the NYMEX Price

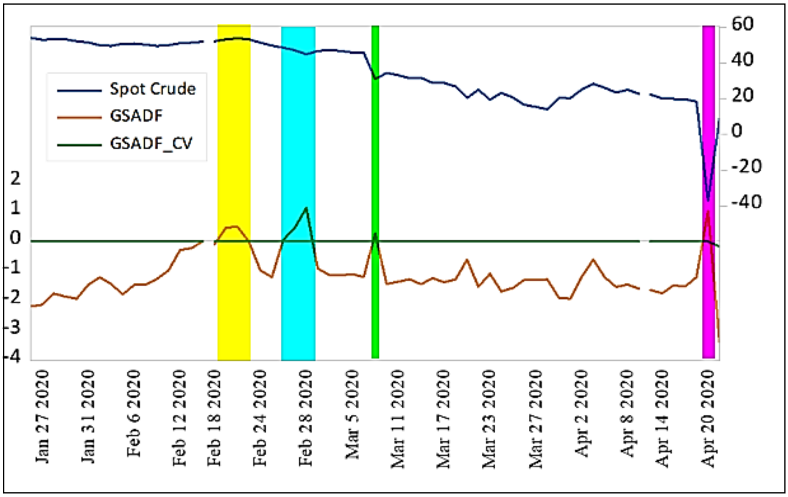


Note. GSADF denotes GSADF sequence; GSADF_CV denotes 95% critical value sequence.

According to the IEA[6], the coronavirus outbreak had caused the first quarterly contraction of oil demand by 435 kb/d in 10 years. The oil market took another major blow in March when Saudi Arabia engaged in a price war with Russia on March 8, 2020. A movement of panic ensued in the energy market, triggering yet another implosion of the oil price bubble, highlighted in the green-shaded area in Figure 7 and Figure 8. The GSADF test picked up another short-lived bubble for the NYMEX index on March 18, 2020 (purple-shaded area in Figure 7), as crude oil price tumbled by another 23 percent during an overnight trade. As oil traders began to accommodate the free fall of the crude oil price over the next four weeks, in the midst of the ongoing price war between Russia and Saudi Arabia reached a stalemate, there was no episode of explosive behavior in the energy market until the 20th of April when oil price turned negative for the first time in history. Both the NYMEX and the Spot Crude prices were traded at 37 US dollars a day before the May futures contracts expired on April 20th. The GSADF statistics for the NYMEX and the Spot Crude were above its critical values for one day on the 20th of April 2020, as is shown in the red-shaded region in Figure 6 and Figure 7, consistent with the monthlong crisis in the oil markets. Overall, findings for the crude oil markets are consistent with the results in the study by Gharib et al. (2021), as it also identified several explosive episodes in the West Texas Light (WTI) oil price during the corresponding period.

Figure 8

Bubbles Date Stamp for the Spot Crude Oil Price



Note. GSADF denotes GSADF sequence; GSADF_CV denotes 95% critical value sequence.

CONCLUSION

The present study has focused on how the COVID-19 pandemic has caused the asset bubbles in the stocks markets of the USA and Malaysia, as well as in the global oil markets. It found that the increase in COVID-19 cases has exacerbated the volatility in the financial markets, as well as in the oil market. The GSADF has provided a powerful explanatory story by documenting a series of bubble in the period between January 1, 2020, to April 24, 2020, for six equity series. The findings showed that the major bubble episodes in the US stock markets were precipitated by the slump in the oil market, and to a lesser extent was due to COVID-19. This finding is consistent with the position of the USA as a major oil producer striding past Saudi Arabia and Russia since 2017. The analysis carried out in this study revealed that the volatility of the US stock markets was more influenced by oil price movements rather than the shock created by COVID-19. This is in line with the findings of Gao et al. (2021). Investors can utilize this information as a prediction and diagnostic tool for future stock prices, as well as an early warning system for economic instability, notably in the US stock market.

In contrast, the stock market in Malaysia exhibited explosive behaviour episodes that correlated strongly with COVID-19 cases. This is not surprising because of the high degree of market integration between Malaysia and its major trading partners, particularly China and the USA. There was also evidence of bilateral contagion effects of bubbles between the oil stock market and the Shariah stock market in Malaysia. Multiple bubble episodes began simultaneously in the crude oil markets (NYMEX and Spot Crude) following the oil price slump in February 2020 and then spread to the Shariah market in Malaysia in March 2020. The explosive behaviour of the stock markets in Malaysia is also explained by the political instability as a result of the collapse of the Pakatan Harapan government in March 2020. These findings have important implications for Government leaders, the single most important was the need to create a stable climate for the financial system so that all other sectors of the economy could thrive, especially during the pandemic.

In comparing the conventional (KLSE) market and the Islamic (Shariah) market, it was found that there was a single bubble episode in the KLSE index, but multiple bubbles in the Shariah index. In particular, the GSADF test was able to pick up two bubble episodes earlier in the Shariah index, both of which coincided with the initial implosion of the COVID-19 outbreak in China, and the impending collapse of the crude oil price. The noteworthy differences of bubble episodes in Malaysia has revealed the sensitivity of the Shariah index to market shocks when the asset prices were heated. The early detection of a bubble episode due to the COVID-19 pandemic from the Shariah index could help protect investors and fund managers in both markets (conventional and Islamic) from impending market crashes. This may be attributed to the rigorous screening of Shariah compliant companies included in the Islamic index, which has excluded gambling and *riba* (unproportionate interest). Furthermore, the strict benchmarking criteria, namely the nature of asset (Jakhura & Mangera, 2010) and the low debt-to-equity ratio (Zandi et al., 2014) for Shariah-compliant companies would ensure that investors' rights were protected. Consequently, this will make investment in Islamic financial markets a viable feature for diversification. However, since the present findings have been limited to the market in Malaysia, it is suggested that further investigation be carried out on the Shariah index of other countries to confirm the current results.

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ENDNOTES

1 Oil Market Report. (April 2020). by the International Energy Agency.https://www.iea.org/reports/oil-market-report-april-2020.

2 Jacobs, Trent. OPEC+ moves to end price war with 10 million B/D cut. pubs.spe.org. *Journal of Petroleum Technology*. Archived from the original on 10 April 2020.

3 Retrieved from https://www.oecd.org/coronavirus/policy-responses/global-financial-markets-policy-responses-to-covid-19-2d98c7e0/

4 (24 February 2020). The Dow Jones Industrial Average and FTSE 100 dropped more than 3%. Retrieved from "Global stock markets plunge on coronavirus fears". BBC News. 24 February 2020.

5 The KLSE index is derived based on Shariah and non-Shariah (conventional) compliant stocks; the Shariah index is calculated

solely on stocks which are Shariah compliant. Information on the listing criteria can be found in https://www.bursamalaysia.com.

6 Retrieved from https://www.iea.org/reports/oil-market-report-february-2020

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